

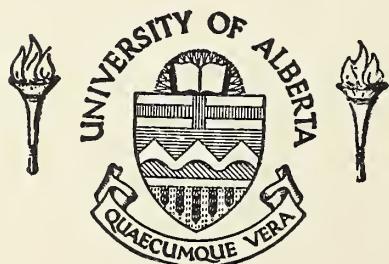
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THE RELATION OF PUPIL ACHIEVEMENT IN SCIENCE TO
TEACHER CHARACTERISTICS AND CERTAIN
ENVIRONMENTAL CONDITIONS

by

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A THESIS

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ABSTRACT

The purpose of this study was to measure teacher effectiveness with class achievement as the criterion. The teacher characteristics that were investigated were as follows: (1) years of academic and professional training; (2) number of physical science courses taken at university; (3) years of teaching experience; (4) length of service in the school system; (5) sex; (6) age; (7) the time spent at teaching duties each week; (8) subject-field preference; (9) feeling of adequate preparation to teach the subject; (10) feeling of permanence in the profession.

The study compared the achievement of city pupils with that of rural pupils. City teachers and rural teachers were compared with regard to six of the characteristics mentioned. The relationship of the grade organization of the school to class achievement was investigated.

The data on teachers were obtained from the survey of the Alberta Teacher Force by the Alberta Royal Commission on Education. The survey was made through the Alberta Advisory Committee on Educational Research. The data on pupils were obtained from the files of the Department of Education. These files also provided identification of students with teachers for most of the classes included in the study. The remaining identification was obtained through correspondence with the principals involved.

The Science marks were adjusted to remove the effects of

differences in the mental abilities of the students. The resulting class scores were expressed as scores in a Class Achievement Index.

The study found significant negative relationships between the Class Achievement Index mean scores and the teacher characteristics of teaching experience and age. A significant positive relationship was found between Class Achievement Index scores and the time that the teacher had spent in the school system. The mean achievement of pupils of undergraduate teachers was found to exceed the mean achievement of pupils of graduate teachers. There were no significant relationships between pupil achievement and other teacher characteristics investigated.

The achievement of rural pupils was found to be better than that of city pupils. Pupils of schools that included all twelve grades achieved better than the pupils of other types of schools. There was a significant negative correlation between class size and class achievement.

City teachers differed from rural teachers in a number of the teacher characteristics investigated: in the amount of academic and professional training, in the number of university-level physical science courses taken, in amount of teaching experience, in the average length of time spent in the school system, in average age, in the number of hours per week that they estimated that they spent at teaching duties. City teachers were more often teaching in their subject-preference field.

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CHAPTER I

THE PROBLEM

I. INTRODUCTION TO THE PROBLEM

The dawn of the Space Age has caused attention to be focused on the field of education. No doubt, educators have always been concerned about efficiency in the classroom, but the great growth in human knowledge in the last few decades forces us to determine much more specifically just what education should do.

It must be recognized that there are many variables which influence the effectiveness of the classroom. There are psychological, as well as physical, factors. Many of the factors which affect the learning process cannot be measured objectively. The measurement of such factors is doubtless being developed and improved. However, more must be known about the effect of those factors which can be measured objectively.

The Royal Commission on Education, Province of Alberta (14:180), stated in its report that the quality of teachers is one of the most important factors in the success or failure of education. The definition of success of education must be subject to what the objectives of education are deemed to be. Walker (18:85) stated that the school exists to provide desirable changes in pupils. The school's achievement of these desirable changes in pupils is no doubt dependent to a considerable extent on the efficiency of the teacher.

Ryans (15:1) has expressed this opinion succinctly:

Both the lay public and professional educators generally agree that the "goodness" of an education program is determined to a large extent by the teaching. The identification of qualified and able teaching personnel, therefore, constitutes one of the most important of all educational concerns. Obtaining capable teachers is an intrinsic interest and obligation of education. If competent teachers can be obtained, the likelihood of attaining desirable educational outcomes is substantial.

The focal importance of the teacher is not new to educational thinking. But in spite of the recognition and lip service accorded good teaching, relatively little reliable information is available regarding its nature and the teacher characteristics which contribute to it (15:1).

Schmid (17) has described the complex nature of teaching:

Teaching is a complex activity carried on in a complex environment--the school. It is directed by complex organisms--human beings. The recipients of the teaching activity are complex individuals, students, whose characteristics are undergoing continuous and complex change.

This great complexity of the educative process necessitates the use of various approaches to the evaluation of teaching. Researchers differ in opinion as to the best means of evaluating. Most of them recognize, however, that there are a number of valid approaches.

Ackerman (1:273) has suggested a number of ways of approaching the problem:

Broadly speaking, the various types of teacher evaluation for competence and effectiveness may be divided into the following categories:

1. Studies based on the consensus of expert opinion to the characteristics and prerequisites of competency and efficiency;
2. Studies using school grades, practice-teaching grades and

ratings of student teaching as the criteria of teaching efficiency;

3. studies using supervisory in-service ratings, self-ratings and ratings by fellow teachers as the criteria of teacher competence;

4. studies using pupil opinion and reaction as the criterion of teacher effectiveness;

5. studies using measured pupil change as the criterion of teacher competence.

Of these, the last approach listed was adopted as the primary aim of this study. This study was designed to determine what relationships exist between pupil achievement and certain teacher characteristics and between pupil achievement and some other factors resident in the organization of the school. Support for this approach has been expressed by Evans (8:89):

Since the teacher is primarily concerned with producing desirable changes in pupils, the most obvious way of assessing the effectiveness of the teacher is to measure the changes in the pupils. In other words, pupil achievement should be the criterion of teaching efficiency.

Any research project is conceived after careful thought about what it is to be measured, in what situations these variables that are to be measured occur, and then how this measurement is to be made. The following statement by Barr (2:5) points out some of the decisions that researchers face in determining how to go about evaluating teaching:

Part of the difficulty associated with the development of an adequate program for the measurement and prediction of teacher effectiveness rises from the fact that teaching means different things. With the situation as it is, the researchers interested in the measurement and prediction of teacher effectiveness have basically two choices; one, to seek the essence of teaching found within a wide range of activities called teaching and the means of predicting efficiency in a variety of situations; or, second, to measure

efficiency in particular learning and teaching situations and predict those particular efficiencies. These particular situations may be carefully controlled situations as found in experimental research or the uncontrolled situations of particular schools, classes, and school systems.

The situations of this present study are not the carefully controlled situations but the uncontrolled situations of a sample of the schools of Alberta. The study has sought relationships of pupil achievement to teacher characteristics rather than to teaching activities.

Remmers (13:641) says, "The essential problem in research on teacher effectiveness is to find which teacher dimensions are related, under what conditions, to specified effects on pupils (the criteria)."

The philosophy and hypotheses expressed in the preceding excerpts were adopted for this study. The study was designed to determine, with pupil achievement as the criterion, what effect some of the objectively measurable characteristics of teachers have on the educational achievement of the pupils of the teachers.

II. STATEMENT OF THE PROBLEM

The Main Problem

The relationships between class achievement and the following teacher characteristics were investigated:

1. the number of years of academic and professional education beyond high school matriculation;
2. the number of university-level physical science courses that had been taken;

3. the number of years of teaching experience;
4. the number of years of teaching service in the school system;
5. the sex of the teacher;
6. the age of the teacher;
7. the time spent at teaching expressed in hours per week;
8. the subject-field preference of the teacher;
9. the feeling of adequate preparation in the subject-field;
10. the feeling of permanence in the profession.

The major problem was whether there were significant relationships between any of these characteristics of Grade 9 Science teachers and the results obtained by their pupils on the Grade 9 Science Final Examination administered by the Department of Education of Alberta in June, 1958.

The Subsidiary Problem

A number of minor problems were investigated:

1. The study sought to determine whether pupils who were taught in city schools achieved significantly better than pupils who were taught in non-city schools.
2. The analysis sought relationships between class size and pupil achievement.
3. The data were tested to find relationships between pupil achievement and the type of grade organization of the school.
4. The analysis sought relationships between pupil achievement and the number and kinds of university degrees held by the teachers.

5. The analysis sought relationships between the mean achievement of pupils of undergraduate teachers and the mean achievement of pupils of graduate teachers.
6. Data for city teachers and for non-city teachers were tested to determine whether one group differed significantly from the other with regard to teacher characteristics investigated.

III. DEFINITION OF TERMS

The following terms are defined as they are to be interpreted in this study:

Questionnaire. The questionnaire that was used in 1958 by the Alberta Royal Commission on Education for the purpose of securing information about the teaching personnel of the Province. The official name of the questionnaire is: "Province of Alberta, Royal Commission on Education, Survey of Alberta Teacher Force, Individual Teacher's Report." (See Appendix A for the pertinent sections.)

Science 9 Final Examination. The examination in Grade 9 Science of June, 1958, prepared and administered by the High School Entrance Examination Board of the Department of Education, Province of Alberta.

Results in the Grade 9 Science Examination. The student scores on the examination as reported to the schools by the Department of Education, expressed in stanine form, but transformed as discussed in Chapter IV.

Stanines. A stanine scale is an approximately normal transformation, only nine categories being used. Ferguson (9:223) states:

The percentage of cases in the stanine-score categories from 1 to 9 are 4, 7, 12, 17, 20, 17, 12, 7, and 4, respectively. Stanine scores correspond to equal intervals in standard deviation units on the base line of the unit normal curve.

Ability Test. The test given by the High School Entrance Examination Board of the Department of Education of Alberta to measure the ability of Grade 9 students. The test given in 1958 was the School and College Ability Test (SCAT).

City teacher. A city teacher is one who taught in the public or separate school system of a city of Alberta. These teachers were identified from the questionnaire as those who checked Item 11 B(1) or Item 11 B(6).

Non-city teacher. A non-city teacher, sometimes referred to as a rural teacher, is one who taught in a school division or county, or one who taught in any kind of independent district other than a city district. The teachers who checked Items 11 A, 11 B(2), 11 B(3), 11 B(4), 11 B(5), 11 B(7), or 11 B(8) were classified in this group.

Content course. A university course in the physical science field if it refers to the courses taken by teachers of this study. The term is used also in reference to other studies wherein it refers to a university course in the subject-field of that study.

Class achievement index. The score obtained by transforming the average science score for the class so that differences due to the intelligence variable have been removed. When such terms as "class achievement" and "pupil achievement" are used, they refer to achievement

as measured by the Class Achievement Index.

Teacher effectiveness. For the purposes of this study, a teacher whose pupils achieved a higher mean score in terms of the Class Achievement Index is deemed to be more effective than a teacher whose pupils' mean score was lower. The term "teacher efficiency" has been used in a synonymous sense.

IV. BASIC ASSUMPTIONS

This study was based on the assumption that a pupil's raw score on the Ability Test (SCAT) is a valid measure of mental ability and that student marks on the Departmental examinations are valid measures of achievement.

V. HYPOTHESES

The following hypotheses were tested:

1. Pupil achievement is significantly higher when the teacher has more years of academic and professional education.
2. The achievement of pupils in Grade 9 Science varies directly as the number of physical science courses included in the teacher's university training.
3. Pupil achievement varies directly with the number of years of teaching experience of the teacher.
4. There is a significant relationship between pupil achievement and the length of time the teacher has spent in the school system.
5. There is a significant relationship between pupil achievement

and the sex of the teacher.

6. There is a significant relationship between pupil achievement and the age of the teacher.

7. There is a positive correlation between pupil achievement and the number of hours per week that the teacher spends on the job.

8. There are significant positive relationships between pupil achievement and such attitudes of the teacher as preference for the subject-field, feeling of adequate preparation for the subject-field, and feeling of permanence in the profession.

9. City pupils achieve higher results than do non-city pupils when the effects of intelligence differences are removed.

10. There is a significant negative correlation between pupil achievement and the size of the class to which the pupil belongs.

11. There are significant relationships between class achievement and the system of organizing the grades of the school.

12. There are significant relationships between pupil achievement and the number and kinds of degrees held by the teacher.

13. The achievement of pupils of graduate teachers is significantly higher than the achievement of pupils of undergraduate teachers.

14. There are differences between city teachers and non-city teachers with regard to the teacher characteristics being studied.

City science teachers have more professional training; they have taken more physical science courses at university; they have more teaching experience; and the average age of city teachers is greater.

15. More city teachers teach in the field of their subject

preference; they spend more time in the school system; and they spend more time at the job each week.

VI. IMPORTANCE OF THE STUDY

The educational authorities charged with the responsibility of teacher selection and of placement require evidence that reveals the value of specialized education in a subject field, the value of experience to teaching effectiveness, and the minimal professional education needed to assure teaching efficiency. Administrators are concerned with the matter of subject preference and related effectiveness in the classroom. The physical factors of class size and grade organization of a school can be controlled rather readily if it is known what the most favorable arrangements are. It is important to know whether some schools are providing educational service superior to the educational service provided by others, and, if so, what features of these schools account for such superior service.

This study, to some extent, parallels studies made by some other Alberta researchers who have thrown some light on the problems mentioned. Lindstedt (11) studied teacher qualifications and pupil achievement determined from results in Grade 9 Mathematics. Wasyluk (20) made comparisons based on results in Grade 12 Mathematics. Eddy (7) studied relationships of results in Grade 9 Social Studies and many of the teacher characteristics studied here. Klufas (10) studied relationships of teacher characteristics and results in Grade 12 Physics. Tetley (18) made a comparison between reading achievement by upper

elementary students and some characteristics of their teachers. A study supported by the Alberta Teachers' Association and conducted by Clarke and Richel (5) sought to determine relationships between class size and pupil achievement as well as relationships of some teacher characteristics to pupil achievement.

Eccles (6) measured achievement of Grade 6 pupils in science using pupil scores from a city-wide testing program in Calgary. She studied the relationship of pupil results with teacher knowledge of the subject. Bodnaruk (4) made a comparative study of pupil results in Grade 9 and Grade 12 with teacher experience and training.

The studies by Lindstedt, Wasylyk, Eddy, and Klufas used the same basic source of information about teachers as this study used. This teacher data was obtained from the study by MacArthur and Lindstedt (12) on the Alberta Teacher Force in 1957-1958. Pupil results were obtained from the Department of Education records. A comparison of the findings of these studies should lead to some useful conclusions about factors that contribute to the competence of Alberta teachers.

VII. LIMITATIONS OF THE STUDY

This study was limited to those teachers in Alberta schools who completed and returned the Alberta Royal Commission on Education questionnaire (May, 1958), and who checked Item 27(4) in that questionnaire. Item 27(4) identified the respondent as a teacher of Grade 9 Science. It is further limited to teachers who had ten or more students in their classes. Since class averages for both the science scores and the

Ability Test (SCAT) scores were used to find relationships sought in this study, and since one extreme score can affect a small sample unduly, the schools with fewer than ten pupils were cast out.

The study included teachers of both public and separate schools, teachers in city schools and rural (non-city) schools. An effort was made to include in the sample teachers with less professional training and less experience. However, the decision to eliminate the small classes, and thus small rural schools, possibly removed many teachers with minimal training and little or no experience. The cases in which there was a change of teachers during the year were also cast out.

VIII. SUMMARY

One of the empirical approaches to the criterion problem in the evaluation of teaching is through measuring the achievement of the product of the teacher's efforts, the pupils. The criterion of pupil change in the study of teacher competence lends itself to objective measurement and thus to statistical treatment. Pupil change would seem to be an accepted criterion by which to evaluate teaching.

Ryans (16:696) has stated:

One of the areas in which we traditionally have expected pupil change is that having to do with the pupil's knowledge and understanding of the physical, biological, and social worlds in which he lives. The teacher is thought of as performing his function effectively in this area if the learning of information and its application proceeds satisfactorily with respect to a majority of the pupils in the class.

In this study, the criterion established is pupil achievement on the Grade 9 Science examination with effects of intelligence

differences removed. A study by Black (3:234) indicated that the examinations administered by the Department of Education of Alberta in the Grade 9 subjects are valid measures of educational achievement.

With results on the Science examination used to determine pupil achievement, the relationships of this achievement to the various teacher characteristics were determined.

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CHAPTER II

REVIEW OF THE RELATED LITERATURE

I. INTRODUCTION

The many studies on teacher effectiveness that have been made by people engaged in educational research indicate the great concern that educators have for identifying efficient teachers. Many of these studies have used means other than measures of pupil achievement to determine teacher effectiveness. There is need for a number of approaches as there is little doubt that an accurate measure of good teaching involves a complex of factors of which pupil achievement is one.

Since this study was concerned with pupil achievement as the criterion, the studies more directly concerned with this factor are the subject of this review. To locate these studies, reference has been made to the annotated bibliographies by Domas and Tiedman (16) and by Watters, (42), and to the reviews of such studies made by Tomlinson (39), and by Barr (4).

The Alberta studies have been reviewed in the last section of this chapter. Some studies that have sought to find the relationship between teacher effectiveness and teacher training have used as a measure the number of university courses that the teacher had taken in the pertinent subject-field. This study reviews in the same section research that used as a measure of professional training the number of

university courses taken and research which used years of professional training as the criterion.

There was little record found of research that has dealt with the sex, the age, or the subject-field preference of the teacher.

II. STUDIES OF ACADEMIC AND PROFESSIONAL TRAINING

The minimum professional preparation of teachers in Alberta is presently less than a university degree. Many educators feel that for the important function which the teacher has in our society, teachers should have more training. The Alberta Department of Education has recently raised the minimum requirement to two years of university education. The Report of the Royal Commission on Education (31:187) has advocated that the minimum requirement of a university degree be established by 1970. The endemic shortage of teachers complicates the problem of staffing schools in a rapidly expanding educational system. The result has been that permission to teach has been given to many people who have even less than the minimum qualifications.

Among the studies seeking the relationship between teacher training and pupil achievement, one of the earliest was done by Rogers (32:146) in 1924. Monroe Silent Reading Tests were given to 166 classes in Grades 3, 4, and 5. He found a positive correlation between pupil achievement in reading and the number of years of professional training the teacher had obtained.

In 1925, Hughes (22) administered three tests of knowledge of physics content to various-sized classes in twenty-nine schools. The

students were equated for intelligence. The students of teachers who had majored in physics made better scores than the students of teachers who had not majored in physics.

In 1928, Barthelmess and Boyer (5) found correlations between teaching efficiency and years of training of +.35 for junior high grades and +.27 for elementary grades. Both of these correlations are significant.

Bergman (7:153) used education tests with 14,000 students in the Michigan State Cooperative Testing Program. He found no appreciable relationship between the amount of teacher training and pupil achievement.

Davis (15:101) found a negative correlation between specialized training of teachers and their pupils' scores in subjects other than chemistry. The students of teachers with higher qualifications in chemistry definitely exceeded those of students of teachers less well-qualified in chemistry. The tests used were the Minnesota State Board Tests of Pupil Achievement. There is no indication that the validity of these tests was established.

In 1938, Allen (2) reported a study in which he concluded that, after a fairly high minimal background had been secured in such items as are normally stressed in what he calls "substantial teacher-training programs," additions to that background did not result in increased efficiency.

A study by Rostker (34:50) used two units in citizenship to measure gain in student achievement. Twenty-eight classes of Grade 7

and Grade 8 students were used. He found a significant positive relationship between results and the teacher's knowledge of subject matter. Various tests were administered to measure the teachers' knowledge of the subject.

In a study of pupils' competence in mathematics, Alkire (1) found that a teacher's T-score (which took into account both teaching experience and training in higher mathematics) showed a positive correlation with pupils' competence.

Bolton (10) used matched pupils and results of achievement tests in United States history to rate teacher effectiveness. He predicted pupil success by using an Otis Quick-Scoring Ability Test, the 1942 Iowa Every-Pupil Test, and a vocabulary test. The Otis Test correlated +.50 and +.47 with the other tests. These are significant correlations. He used the pupil scores to determine the relative efficiency of teachers.

LaDuke (26) sought to determine the validity of certain teacher tests and rating scales as measures of teaching efficiency when pupil change was employed as the criterion. His sample included 31 teachers of one-room rural schools and approximately 200 pupils in the seventh and eighth grades. The teacher of each school taught eight units on Community Living following closely a time schedule. Tests were administered at the beginning of the school year and at the end. A pupil-gain criterion was produced by adjusting, regression-wise, the post-test scores for I.Q., mental age, and pre-test variation. Five tests were administered to the teachers measuring intelligence, attitudes, and

knowledge of educational psychology. The teachers were also rated by the superintendent and by supervisory teachers. LaDuke found little relationship between the ratings and the pupil-gain criteria.

Jones (24) used objective measurements of teaching efficiency and sought to determine the effect of better teacher preparation. He concluded that, "Achievement in formal education courses seemed to be the most relevant variable to pupil gain." He had measured the achievement of teachers in various courses.

Some Baltimore teachers of Grade 5 arithmetic were the subjects of a study done by Stephens and Lichenstein (37). Class achievement was determined by a formula yielding a class-efficiency score and by taking intelligence differences into account. The study revealed a negative correlation with teacher preparation in arithmetic.

Schunert (35) studied pupil achievement in algebra and geometry and the academic preparation of their teachers. The Minnesota State Board Examinations were used. He found no significant relationship.

Morsh, Burgess, and Smith (29) found no significant relationship between the knowledge of air force instructors and the subject-matter achievement of their students.

A 1959 study by McCall and Krause (28) used Grade 6 teachers and pupils from some rural and city schools in North Carolina. Pupil achievement in nine areas was measured and then measured again eight months later. The amount of growth in these areas was used as a measure of teacher competence. The results showed some positive but not significant correlations between the teachers' knowledge of the subject-matter

and pupil achievement.

A recent investigation (21) involving 55 teachers of elementary grades in Brooklyn, New York used pupil achievement as the criterion and considered a number of variables in relation to this. Such variables as the teacher's knowledge of professional education and the liberal arts were found to have no significant relationship. However, the effect of liberal arts knowledge approached significance at the .05 level.

In a study to determine the relationship of pupil achievement in a number of subjects to teacher characteristics, Chung-Phing Shim (13) used 89 teachers and their elementary school pupils. He used a college grade-point average (GPA) to measure teacher success in college courses. Other characteristics were: whether the teacher was a graduate or not, whether the teacher was certified or not, and the amount of teaching experience. Pupils were classified by mental ability. His general conclusion was that pupils reached the level of attainment expected of them regardless of the characteristics of the teachers that had taught them over a four- or five-year period.

III. STUDIES OF TEACHING EXPERIENCE

In teachers' salary schedules, of the variables which determine an increase in pay from year to year, one variable is an annual increment based on teaching experience. This fact assumes that a teacher's competence increases with experience for a period of one to ten or more years. Those studies which have used pupil growth or achievement to determine the effect of teaching experience are summarized here. Some of

the studies already mentioned also looked at the effects of experience and are referred to again in this section.

Rogers (32:146) found a positive correlation between pupil achievement and years of teaching experience up to eight or nine years.

Bergman (7:153) found no significant relationship between teaching experience and achievement of homogeneous groups of students.

Davis (15:102) found that two years of experience was better than one but that there was little difference for experience beyond the two years.

In 1935, Betts (8:235) classified the fifty-four teachers of his study into novices and experienced teachers. He administered a test to these two groups. The test consisted of twelve sub-tests designed to measure certain variables thought to be essential to successful teaching. The scoring scheme was revised so that the experienced teachers scored higher than the novices. The test was then administered again. Then a standardized achievement test was administered to the 1,214 pupils of these teachers. The criteria of teaching ability were these scores. The correlation between the novice-experienced dimension, that characteristic which distinguishes reputedly superior teachers from novice teachers, and pupil change with pupil ability and age held constant was found to be highly significant.

Moss, Loman, and Hunt (30) found that the highest median scores in introductory college chemistry were achieved by students of instructors with one to eleven years of experience and that lower median scores were achieved by pupils of instructors with more than twelve years

of experience. Classes had been equated for size, for intelligence of pupils, and for previous training in chemistry.

Some positive correlation for the first years of experience was found by Stephens and Lichenstein (37:693):

Judging from the gross relationships, experience seems beneficial for the graduates of the State Normal School (range of experience from 0 - 9 years) and slightly detrimental to the graduates of the City Training School (with a range of from 4 to 24 years of experience).

Schunert (35:233) states:

Classes taught by teachers who had more than eight years of experience exceeded the achievement of classes taught by teachers of less experience. No significant difference was found between the achievement of classes taught by teachers of less than two years experience and achievement of classes taught by teachers having from two to eight years of experience.

As a result of a study which sought to measure the effect of years of teaching experience on pupil achievement, McCall and Krause (28) attributed more overall pupil growth to younger teachers than to older teachers and thus discounted experience as a favorable factor.

Bathurst (6) used pupil achievement and sought to determine its relationship to teaching experience. He was careful to validate his criterion. He found no significant relationship between pupil achievement and teaching experience after the first year.

The teaching ability of fifty-seven Grade 7 and Grade 8 teachers was evaluated by Rolfe (33). He gave the pupils validated tests on educational objectives before and after instruction on several units in citizenship. He made adjustments for pupils' individual differences in intelligence, in socio-economic status, and in initial achievement by means of a multiple-regression procedure. Thus gains by the pupils were

used to determine a teacher's efficiency. He found that there was little gain to attribute to increased experience.

IV. STUDIES ON SEX OF THE TEACHER

It seems that little has been done to determine whether male teachers are more effective at certain grade levels than female teachers and vice versa.

Cheydleur (12:180) concluded that students of women teachers achieved slightly better than students of men teachers but that the results were not significantly different.

Barr (4:121) concluded that, in view of research findings to that time, female and male teachers were equally effective with boys or with girls at each grade level. He saw a need for more research.

V. STUDIES ON AGE OF THE TEACHER

Many studies have sought to determine the relationship of teacher age to efficiency and the findings have not generally favored the older teacher.

Rolfe (33), in his experiment on the units in junior high citizenship to determine pupil change in relation to teacher factors, found no significant relationship with age.

Bathurst (6) found that efficiency tended to decrease with increase in the age of the teacher but that differences were not statistically significant.

In his study of pupil gains in the knowledge of United States

history in the classes of sixty-six male high school teachers in Indiana, Brookover (11) found that pupil information increased with the age of the teacher up to thirty-eight years and then decreased. The greatest gains in pupil knowledge was for the ages of twenty-seven to thirty-eight years.

Johnson (23) investigated the efficiency of a group of teachers who had graduated from a southern United States university but found no significant relationship to age.

VI. STUDIES ON CLASS SIZE AND TEACHER LOAD

The load which a teacher is carrying as compared with the loads of fellow teachers is a complex thing to measure. Some studies have striven to measure load by class size, some by the amount of teaching time, and some by the nature of the subjects taught in terms of marking load, preparation time, and so forth.

A formula for measuring teacher load by a weighting of subjects was worked out by Douglass (17). Later, he and Noble (18) revised the formula and made another study of it. The revised formula took into account subject difficulty, grade level, duplication of class materials, number of pupils and other factors. They studied the effects on teacher efficiency of the various load factors. One finding was that smaller classes yielded better results than larger classes.

Cheydleur (12) experimented with students in basic French courses. He found that pupils in classes of nine to eighteen pupils did better than pupils in classes of nineteen to thirty-three pupils.

Anderson (3) reported that chemistry students achieved significantly higher scores when the number of students handled per day by the teacher was in the lower one-fourth of the distribution rather than in the higher one-fourth.

Schunert (35) found that classes of twenty to thirty students exceeded the achievement of both larger and smaller classes.

The achievement of one hundred seventy-nine classes in Iowa cities was measured by Spitzer (36). He used the Every-Pupil Tests of Basic Skills. He found no significant difference in average scores in reading comprehension, study skills, language skills, and arithmetic skills of students in classes of twenty-six or fewer and average scores of students in classes of thirty or more.

VII. ALBERTA STUDIES

This section of the chapter is devoted to studies made by Alberta researchers. The areas of investigation will be dealt with in the same order as that used for other studies previously reviewed.

Academic and Professional Training

On investigation of the relationship of professional training to pupil achievement, Lindstedt (27:35) found that there was no significant relationship up to four years but that the amount of training was significant after four years. Teachers of Grade 9 Mathematics with five or six years of professional training obtained better pupil achievement.

Wasyluk (41:57) found that results for those Mathematics 30

teachers with one to four years of training were lowest and that the results for those with five years were not much higher. Those with six years training obtained results far higher.

Eddy (20:29) found that training had a significant positive relationship. He reports that students of social studies teachers with three and four years of training did significantly better than did the pupils of teachers with two or fewer years. Those with five years of training also obtained better results but for those teachers with six years of training the results were poorer.

Tetley (38:46) made a study of pupil achievement in reading in Grades 4, 5, and 6. She used analysis of covariance to determine teacher effectiveness with reading scores as the criteria. These scores had been adjusted for both pupil intelligence and previous reading achievement. She reports a tendency for teachers with more training to be more effective in inducing pupil achievement in reading. In the analysis of the effectiveness of extra training in the teaching of reading, she found that results favored significantly the teachers with such training over those without it.

Klufas (25:50) found no significant correlation between pupil achievement in Physics 30 and years of professional education of the teacher.

Clarke and Richel (14:29) found that the teachers of one city had considerably higher qualifications than did the teachers of another city. The pupils of the first city showed higher results. This indicated a positive relationship between pupil results and the amount of professional

education of the teacher.

Bodnaruk (9:103) found that specialized training of the teacher had no bearing on student achievement.

Lindstedt (27:43) found no significant differences in pupil achievement related to the number of content courses in mathematics taken by the teacher. Wasylyk (41:40) and Eddy (20:35) found a definite positive relationship. Eccles (19:244) found no significant correlation between the teacher's knowledge of the subject matter and the pupil achievement in science. Tetley (38:47) and Klufas (25:71) found that the effects were positive and quite significant.

Teaching Experience

In investigating the effects of the amount of teaching experience on student achievement, Lindstedt (27:51) found a significant difference between results obtained by teachers with one year of experience and the results obtained by teachers with ten or more years. He found that teachers with five to nine years of experience were more effective than teachers with three to four years.

Wasylyk (41:47) found that pupil achievement for teachers with twenty to thirty-four years of teaching experience was higher than pupil achievement for teachers with more or less experience. He also found that pupil achievement was significantly better for teachers with ten to nineteen years of experience than for teachers with thirty-five years or more. Both Wasylyk and Lindstedt found a significant positive relationship when training and experience were grouped.

Eddy (20:36) found a significant positive relation with experience

up to nineteen years and then the effectiveness decreased. He found decreasing effectiveness with more experience for those teachers with less than four years of training. However, for those teachers with more than twenty-five years of experience but less than four years of training the results were significantly higher.

Klufas (25:73) found that teachers with more experience obtained significantly higher results. Those with fifteen to nineteen years were the most effective.

Tetley (38:50) found a significant relationship between pupil achievement in reading and years of teaching experience. Those teachers with five to ten years of experience had better results at the Grade 4 level and those with two to four years had better results at the Grade 5 level.

Clarke and Richel (14:32) were not able to determine the relationship of teaching experience with pupil achievement. Their study found little difference in amount of experience between the groups of teachers, thus no differences could be attributed to this factor.

Bodnaruk (9:103) found that pupil achievement had little relationship to the teacher's experience.

Sex of the Teacher

Tetley (38:54) found that women obtained higher pupil achievement (significant at the .01 level) with pupils in Grade 4 and that men were more effective (.05 level) with pupils in Grade 6.

Eddy (20:47) found that differences associated with the sex of the teacher did not reach the level of significance.

Age of the Teacher

Eddy (20:38) and Tetley (38:55) investigated the effect of the teacher's age on pupil achievement and both concluded that there was no significant relationship.

Teacher's Subject Preference

Lindstedt (27:46), Waslyuk (41:51), Eddy (20:48), and Klufas (25:69) all found a significant positive relationship between the teacher's subject-preference, when the teacher's preference was in the subject-field studied, and the achievement of pupils.

Class Size and Teacher Load

Eddy (20:38) found no significant relationship between pupil achievement and the size of class. He also found no significance attached to time spent on the job by the teacher (20:43). Clarke and Richel (14:71) found that best results were obtained in smaller classes.

School Organization

The study by Eddy (20:47) found that pupil results are better for schools of twenty-five or more teachers. He found that differences in pupil average scores for schools of other sizes were not statistically significant.

Results of City Pupils and Rural Pupils

Lindstedt (27:27) and Klufas (25:44) found no significant differences in the marks obtained by pupils of city schools and the marks obtained by pupils of non-city schools. Waslyuk (41:39) found that

pupils of city schools had better results. Lindstedt did not use an intelligence control but Wasylyk and Klufas did. Results of city students studied by Eddy (20:64) were significantly higher than those of the rural students of his study.

Comparison of City Teachers and Rural Teachers

Lindstedt, (27:23), Wasylyk (41:34), and Klufas (25:64) found that city teachers had more training than rural teachers. Klufas (25:64) found that city physics teachers had more additional courses in the physical sciences. All found that city teachers did not differ from rural teachers in average amount of teaching experience (20:22, 41:36, 25:66, 20:64).

Eddy (20:57) found that city teachers exceeded rural teachers in the amount of training obtained. He also found that city teachers were more often assigned to subject preference (20:46). Wasylyk (41:37) found no significant differences in this respect. Klufas (25:67) found a greater proportion of city teachers in their subject-preference field. Eddy (20:58,61) found no significant differences between city teachers and rural teachers in age or in time devoted to the job.

VIII. SUMMARY OF FINDINGS IN RESEARCH CITED

1. The consensus of opinion in the research reviewed here is that there is a positive correlation between student achievement and the amount of professional training that the teacher has received. Some studies do not indicate the minimum training requirements; the minimum requirement in most cases was a university degree.

2. The conclusions regarding the relationship between teaching effectiveness and amount of teaching experience were rather varied. Most agree that the first ten years or so of teaching experience bring increased efficiency.

3. Some of the Alberta studies found that teaching efficiency increased when a teacher was working in his subject-preference field.

4. Few studies found any significant relationship between either the sex or the age of teachers and the achievement of their pupils.

5. Studies that made an analysis of the effects of the size of the class on pupil achievement generally favor classes of fewer than thirty pupils.

6. The pupils of teachers who had taken a number of university courses in their subject specialty were found generally to have attained higher marks than the pupils of teachers with fewer such courses.

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CHAPTER III

SAMPLING AND DATA COLLECTION

In this chapter the sources of the data on teachers and on their classes are discussed. The particular procedures used to arrive at the sample are explained.

I. DATA ON TEACHERS

In 1958 the Alberta Royal Commission on Education directed, by questionnaire, a comprehensive survey of the teacher personnel of the province (4). The questionnaire (4:65) was returned by over ninety-nine per cent of the teachers. Data on certain teacher characteristics thus secured have been used in this study. The information used was obtained from the parts of the questionnaire reproduced in Appendix A.

At the beginning of each school year, principals of high schools and of junior high schools complete for the Department of Education a report known as the Principal's Form A Card. This report provides information about the organization of the school, the names of the teachers, and teacher allocation to subjects. The Principal's Form A Cards of September, 1957, were used to identify Grade 9 Science teachers with their schools.

The Population

There were 685 Grade 9 Science teachers who returned the questionnaire (4:52). Of this number, 128 were teachers in city schools

and 557 were teachers in non-city schools.

Since the study used class average scores transformed to remove effects due to intelligence differences, schools with fewer than ten Grade 9 students were cast out. This has removed many of the small rural schools and has also reduced the number of first-year teachers that might have been included.

A problem arose in the identification of pupil with teacher in schools that had more than one teacher of Grade 9 Science. To make such identification, the letter in Appendix B was sent out to the principals of these schools. The letter was accompanied by a list of the names of all the Grade 9 students of that school asking that the pupils be identified with the teachers by reference to the school records. The names of the teachers were placed on the list and a simple code provided.

The response to these requests was excellent. Three schools found that they did not have the necessary records. Only two schools did not comply because of the amount of work involved. There had been changes of teachers during the year in some schools. Where this change occurred after the year was well begun, the school was cast out of the sample.

For the sample of city schools, the schools were identified as to whether they were in the public school system or in the separate school system. From these groups and from the rural schools remaining, a table of random numbers was used to select 50 city school classes and 130 rural school classes. In cases where one teacher had several

classes, these classes were considered as one class for the purpose of determining the Class Achievement Index.

The 50 teachers of city schools constituted 39.1 per cent of the city teachers of Grade 9 Science who responded to the questionnaire. The 130 non-city teachers constituted 23.3 per cent of the total of non-city Grade 9 Science teachers who responded. Of the 685 teachers who responded, 26.3 per cent are included in this study.

Of the 180 teachers in the sample population, the numbers responding to the pertinent items of the questionnaire are shown in Table I.

TABLE I

NUMBER OF TEACHERS RESPONDING TO EACH QUESTIONNAIRE ITEM
USED IN THE STUDY

Item Number													
4	6	7	15	18	28a	39	40	41	42	50	51	53	
156	178	178	180	174	80	167	166	179	176	178	180	179	

The investigator realized that the relatively small number of teachers who responded positively to Item 28(a) may have produced a biased sample. This item identifies teachers who have taken university courses in the physical sciences.

II. DATA ON PUPILS

The classes of students were selected as explained in the first part of this chapter.

The Examinations Branch of the Department of Education has the achievement records of the Grade 9 students for the Departmental

Examinations held in June, 1958. The marks in science and in the Ability Test for each student of the selected classes were obtained from these records. The science scores are recorded in stanine form and the Ability Test scores are recorded as raw scores.

For schools with more than one teacher in Grade 9 Science, pupil names were listed for each school. These were sent for identification to the appropriate schools. The pupil scores for those schools used in the study were obtained later. For schools with one science teacher in Grade 9, the individual scores for pupils were recorded but no attempt was made to list names of students. Only those classes were used for which students and teacher were positively identified.

The Population

The total number of students used in this study was 6,771. This constituted 39.0 per cent of the total of 17,379 Grade 9 students of that school year (1:68). Of these students, 3,285 or 48.5 per cent were students in rural schools and 3,486 or 51.5 per cent were students of city schools.

III. THE EXAMINATIONS USED

Principals' ratings were used in the determination of the final marks in Science and in Social Studies in Grade 9. The final mark awarded the student by the Department of Education in 1958 was therefore an average of the result of the final examination mark and the principal's confidential mark in Science. Research (2:284) has shown that the principals' marks are an accurate prediction of final examination marks

and therefore the final assigned grading and the result on the final Science examination were not appreciably different. It was not possible to determine whether this held true for this particular sample but the relatively large number of pupils involved makes it probable that it did hold true.

The mark assigned to each student did not take into account any differences in intelligence. The test administered in June of 1958 to determine the ability of students was the School and College Ability Test (SCAT). This test measures, to some extent, skills and abilities beyond academic aptitude. However, it is the only available test of ability for the entire sample of students.

The Class Achievement Index scores used in this study are the scores in achievement in Science with effects of intelligence differences removed.

IV. TESTS OF DATA FOR NORMAL DISTRIBUTION

The chi-square test for goodness of fit was applied to the distributions of the Science scores and of the Ability Test scores. The results of the calculations are summarized in Table II for the Science scores and Table II for the Ability Test scores.

An examination of the results of these tests reveals that the distributions depart significantly from normal. In order to determine the nature of the departure, the observed and expected frequencies of the Ability Test scores are shown in Figure 1, page 43. The distribution is platykurtic. With the later transformation to normally

TABLE II

COMPARISON OF OBSERVED AND EXPECTED FREQUENCIES IN SCIENCE STANINE SCORES OF THE PUPIL SAMPLE

Stanine	O	E	O - E	$(O - E)^2/E$
9	284	271	13	.62
8	510	474	36	2.78
7	826	813	13	.21
6	1137	1151	-14	.17
5	1183	1354	-171	21.67
4	1146	1151	-5	.02
3	958	812	146	26.25
2	482	474	8	.13
1	245	271	-26	2.49
Totals	6771	6771	df = 8	$\chi^2 = 54.34$ $p < .01$

TABLE III

COMPARISON OF OBSERVED AND EXPECTED FREQUENCIES IN ABILITY TEST SCORES OF THE PUPIL SAMPLE

Interval	O	E	O - E	$(O - E)^2/E$
116 & over	0	19	-19	19.00
106 - 115	16	72	-56	43.56
96 - 105	297	250	47	8.84
86 - 95	741	607	134	29.42
76 - 85	1120	1093	27	.67
66 - 75	1303	1497	-176	20.94
56 - 65	1314	1417	-103	7.49
46 - 55	1123	1029	94	8.58
36 - 45	633	529	104	20.44
26 - 35	202	204	-2	.02
16 - 25	22	58	-36	22.34
to 15	0	14	-14	14.00
Totals		6771	6771	$\chi^2 = 195.30$ $p < .05$

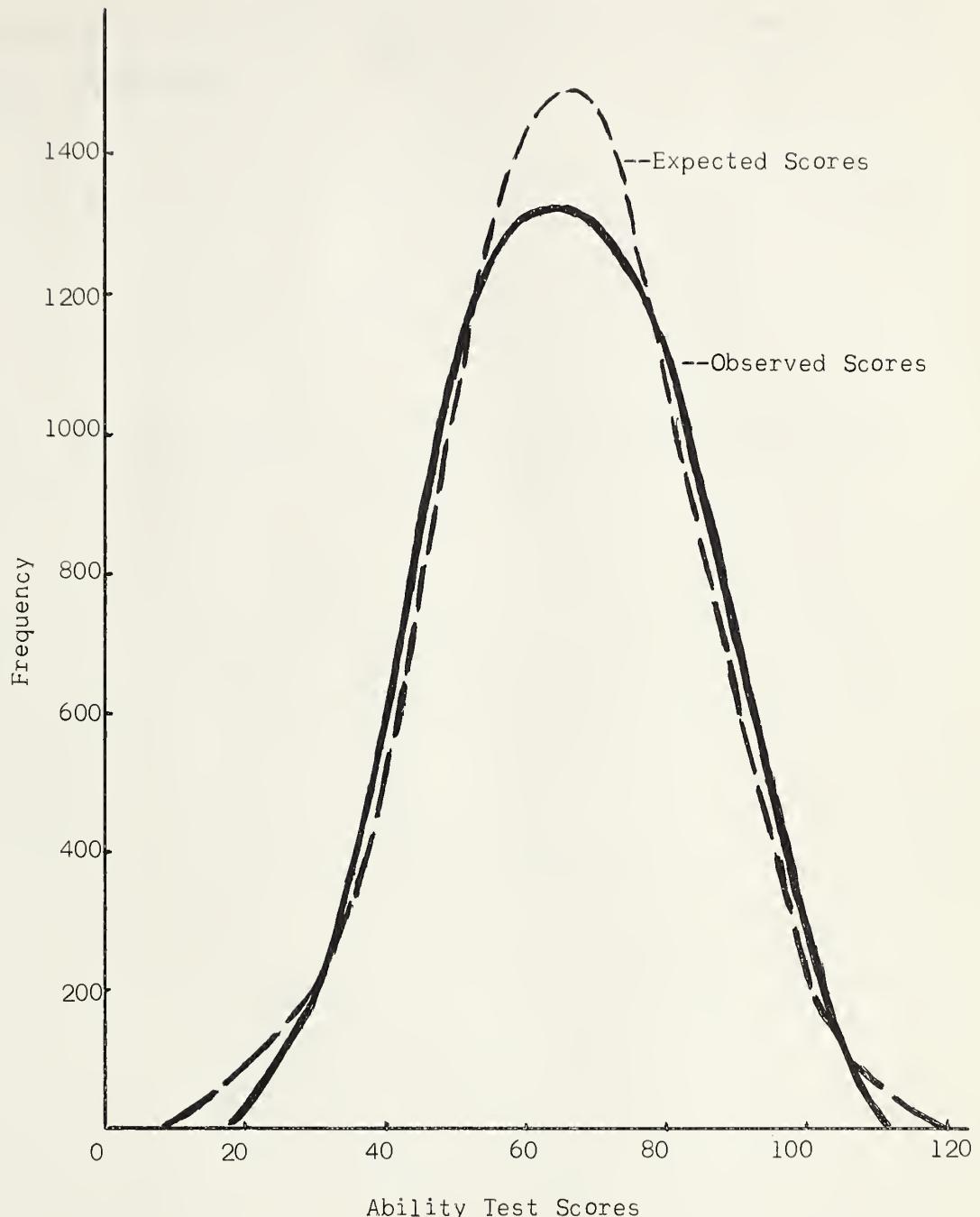


FIGURE 1

FREQUENCY DISTRIBUTION OF ABILITY TEST SCORES OF THE SAMPLE
COMPARED WITH A NORMAL DISTRIBUTION

distributed Class Achievement Index Scores, the findings should not be appreciably altered.

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CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

This chapter is devoted to the statistical treatment of the data, interpretation of the results, and discussions of the findings. The various statistical treatments, varied to suit the nature of the variables involved, are discussed in connection with the analyses.

In the correlations, if the probability p has a greater value than .05 ($p > .05$), the relationship between the variables was not considered significant. If p was less than .05 ($p < .05$), the interpretation was that there is a significant relationship. A value of p of less than .001 ($p < .001$) was taken to indicate a very significant relationship.

I. DETERMINATION OF CLASS ACHIEVEMENT INDEX

The frequency distributions of the science scores (Y) and of the Ability Test scores (X) are shown in Table XIX, page 96, in Appendix C. The correlation coefficient of these scores was found to be +0.73. Thus prediction of science scores from Ability Test scores can be made with fair assurance.

The regression equation for predicting a science score (Y') from the Ability Test score (X) was calculated using all individual student scores. The resulting equation is:

$$Y' = 0.084X - 0.55$$

The average science score for each class was calculated. A science score for the class was predicted. The difference between these scores provided an index. If the actual average score was larger than the predicted score, the index for that class ($Y - Y'$) was positive. If the predicted score was the larger score, the index was negative. These index scores were converted to whole, positive numbers by removing the decimal (multiplying by 100) and then adding the constant 162. This procedure resulted in what were called class index scores. Table IV shows a sample of the procedure followed to arrive at this class index.

TABLE IV
DETERMINATION OF CLASS INDEX

Class	Class Average Science Stanine	Predicted Science Score	Index	Class Index
A	4.23	4.74	-.51	111
B	5.87	5.36	+.51	213
C	5.35	5.96	-.61	101
D	6.04	5.84	+.20	182

The class index scores were converted to T-scores as shown in Table V. These T-scores are the Class Achievement Index. A Class Achievement Index score was interpolated for each class and then recorded on the card containing the data for the teacher of that class.

TABLE V

CONVERSION OF CLASS INDEX TO CLASS ACHIEVEMENT INDEX

Class Interval	Midpoint	Frequency	Cumulative Frequency to Midpoint	Cumulative Percentage to Midpoint	Normal St. Dev. Unit z	Class Index (T-Scores)	z x 10 z x 10+50
361 - 380	370.5	3	178.5	99.17	2.40	24.0	74.0
341 - 360	350.5	2	176.0	97.78	2.01	20.1	70.1
321 - 340	330.5	2	174.0	96.11	1.76	17.6	67.6
301 - 320	310.5	2	172.0	95.56	1.70	17.0	67.0
281 - 300	290.5	8	167.0	92.78	1.46	14.6	64.6
261 - 280	270.5	8	159.0	88.33	1.19	11.9	61.9
241 - 260	250.5	7	151.5	84.17	1.00	10.0	60.0
221 - 240	230.5	15	140.5	78.06	0.77	7.7	57.7
201 - 220	210.5	19	123.5	68.61	0.48	4.8	54.8
181 - 200	190.5	16	106.0	58.89	0.22	2.2	52.2
161 - 180	170.5	23	86.5	48.06	-0.05	-0.5	49.5
141 - 160	150.5	25	62.5	34.72	-0.39	-3.9	46.1
121 - 140	130.5	14	43.0	23.89	-0.71	-7.1	42.9
101 - 120	110.5	19	26.5	14.72	-1.05	-10.5	39.5
81 - 100	90.5	5	14.5	8.06	-1.40	-14.0	36.0
61 - 80	70.5	9	7.5	4.16	-1.73	-17.3	32.7
41 - 60	50.5	1	2.5	1.39	-2.20	-22.0	28.0
21 - 40	30.5	1	1.5	.83	-2.40	-24.0	26.0
1 - 20	10.5	1	0.5	.28	-2.77	-27.7	22.3
				180			

II. STATISTICAL ANALYSIS

Pearson's product-moment correlations (1:89) were used to determine the relationships between variables of the interval or ratio type. Results of calculations are summarized in tables.

Point-biserial correlations (2:262) were used to determine the relationships between the Class Achievement Index and the dichotomous variables. The appropriate value of t (1:202) was calculated for each point-biserial correlation and the significance of the correlation thus determined. The results of these correlations were summarized in tables also.

Academic and Professional Education

The relationships of the Class Achievement Index to the amount of professional training and to specialization in science are shown in Table VI.

TABLE VI
RELATIONSHIPS BETWEEN THE CLASS ACHIEVEMENT INDEX AND
TEACHER EDUCATION

Teacher Characteristics	N	Mean Class Achievement Index	Correlation r	Significance P.05 = .195
Academic and Professional Training	178	50.2	-.18	NS
University Science Courses	80 ^a	49.2	-.01	NS

^aSmall number of cases has been noted.

The amount of professional training that a teacher has had did not seem to affect the Class Achievement Index significantly. The correlation (-0.18) tended to be negative but did not reach the level of significance ($p_{.05} = 0.195$). The data was checked carefully to determine whether there might be a curvilinear distribution. There was no particular departure from a straight line relationship.

Statistical analysis indicated that class achievement in Grade 9 Science, as measured by the Class Achievement Index, did not vary significantly with the number of university-level physical science courses that the teacher had taken. The small number of teachers in the sample who reported having taken such physical science courses throws doubt on the validity of any conclusions drawn from the statistical analysis of the data.

Professional educators commonly assume that a teacher's efficiency is proportional to the amount of professional training of the teacher. It has been rather generally agreed that this training should include special knowledge of the subject field to be taught. The analysis of this data does not verify these premises.

The investigation was carried further in that comparisons of pupil mean achievement scores were made on the basis of the university qualifications of the teachers. The results of these comparisons are summarized in Table VII. Comparisons were made on the basis of whether the teacher held the Bachelor of Education degree or the Bachelor of Arts or Bachelor of Science degree. There was no significant difference. A comparison was made on the basis of whether the teacher held one

degree or two degrees. There was no significant difference but the tendency was in favor of the teacher with one degree. The indication was that teachers with one degree are as effective as teachers with two degrees. In the comparison of the results of the pupils of undergraduate teachers with the results of pupils of graduate teachers, the results of the pupils of undergraduate teachers were significantly higher. The difference reached significance at the .01 level.

TABLE VII

RELATIONSHIPS BETWEEN THE CLASS ACHIEVEMENT INDEX AND THE UNIVERSITY QUALIFICATIONS OF THE TEACHER

Teacher Characteristics	Variables	Means	Ratio	r_{pbi}	t	Significance $t_{.05} = 1.98$ $t_{.01} = 2.62$
Degree Held	B.Ed.	46.03	.62	.05	0.31	NS
	B.A./B.Sc.	45.09	.38			
	One degree	49.57	.70	.18	1.46	NS
	Two degrees	45.67	.30			
	No degree	56.19	.69			
	One or more degrees	45.67	.31	.49	6.85	.01

There were no significant differences in pupil mean achievement scores when comparisons were made on the basis of the faculty in which the teacher held his or her degree. Pupil results were no different for teachers with one degree than for teachers with two degrees. In the comparison of pupil mean achievement scores for undergraduate teachers and for graduate teachers, the pupils of undergraduate teachers achieved

significantly better scores.

Teaching Experience

The number of years of teaching experience that the teacher had had was used as the basis for comparison of pupil mean achievement scores. The results of statistical computations are summarized in Table VIII.

TABLE VIII
RELATIONSHIPS BETWEEN THE CLASS ACHIEVEMENT INDEX AND TEACHING TIME

Teacher Characteristics	N	Mean Class Achievement Index	Correlation r	Significance p. _{.05} = .195
Teaching Experience	179	50.2	-.26	.01
Time spent in the system	176	50.2	.32	.01

The correlation of -.26 is significant at the .01 level. To determine whether this rather decided negative correlation might be due to a curvilinear relationship in the data, a graph, as shown in Figure 2 was constructed. Some curvilinearity is revealed but statistical computations do not indicate significant departure from a straight line relationship. However, the pupil achievement for teachers with ten to fourteen years of experience tends to be higher than the achievement of pupils whose teachers had more or less experience.

The relationship between pupil achievement, as measured by the Class Achievement Index, and the number of years of experience of the

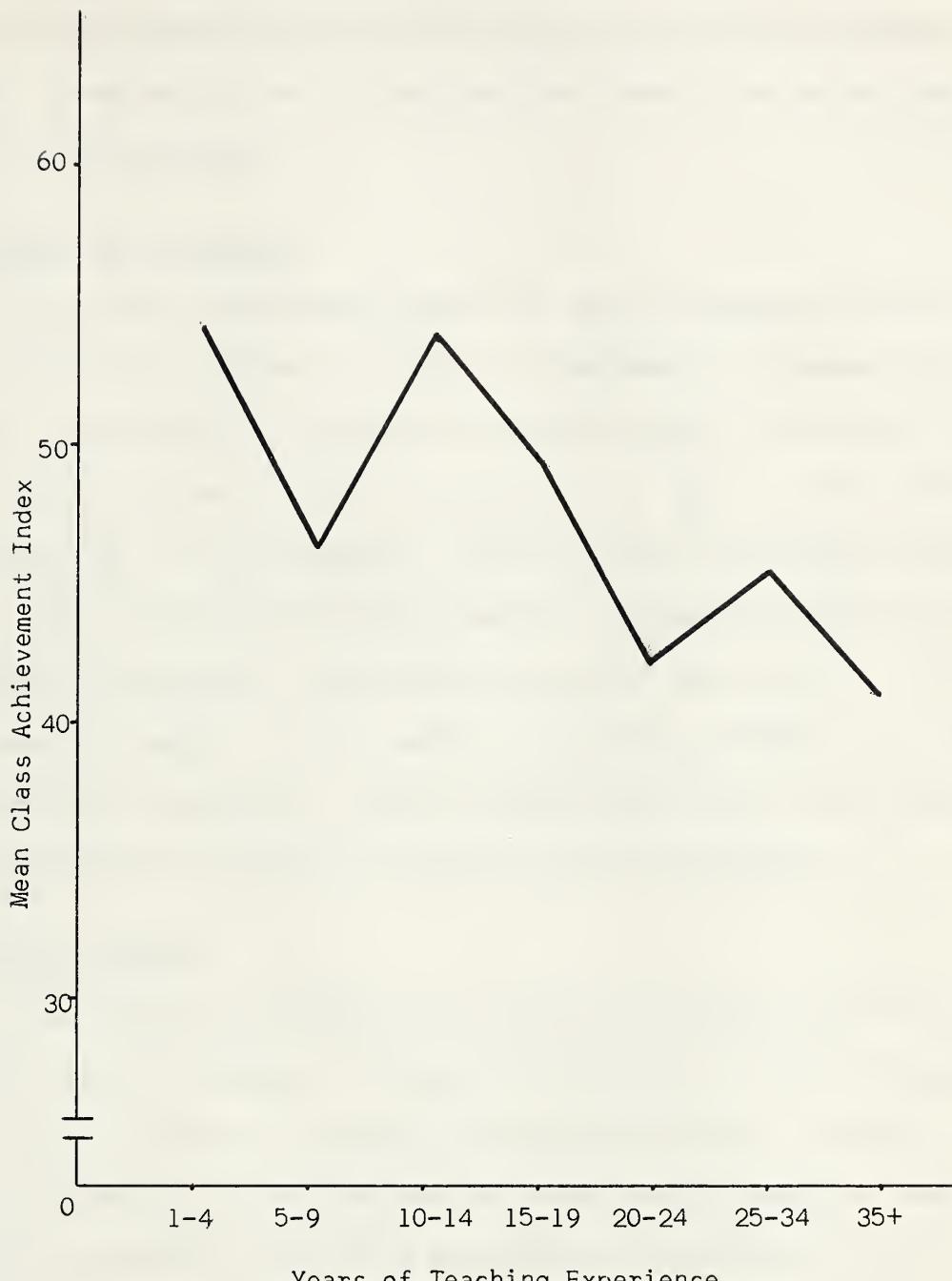


FIGURE 2

THE MEAN CLASS ACHIEVEMENT INDEX BASED ON YEARS OF TEACHING EXPERIENCE

teacher reaches significance at the .01 level. The relationship is a negative one indicating that increased experience is not a favorable factor. Experience of ten to fourteen years tends to be better than more or less experience.

Time Spent in the System

Pupil mean achievement scores were used to determine whether long service by a teacher in a school system leads to increased efficiency. The results of calculations are summarized in Table VIII, page 53. The correlation of +0.32 is significant at the .01 level. This indicates that it is desirable to retain teachers in the school system.

This positive correlation appears to contradict the finding that experience is negatively correlated with teacher efficiency. It is reasonable to expect that the teacher with long experience is also the teacher with long tenure. There is probably some other factor than those considered here that is influencing the relationships.

Sex of the Teacher

The question of whether men or women are the more effective teachers was investigated. The mean achievement scores for the pupils of teachers of each sex were calculated and statistical tests were made. Results of the calculations are summarized in Table IX. Point-biserial correlation was used to determine the relationship. No significant relationship was found. Other studies that have investigated the relationship of sex to teaching efficiency have commonly found that the differences are not significant.

TABLE IX

RELATIONSHIPS BETWEEN THE CLASS ACHIEVEMENT INDEX AND
SOME TEACHER CHARACTERISTICS

Teacher Characteristics		N	Mean Class Achievement Index	Ratio	Correlation	Significance $t_{.05} = 1.98$ $t_{.01} = .195$
Sex	Male	129	49.48	.72	$r_{pbi} = .16$	NS
	Female	51	52.07	.28	$t = 1.56$	
Age		179	50.2		$r = -.26$.01
Time spent on job ^a		178	50.2		$r = -.03$	NS

^a Teacher estimate of hours per week spent on the job.

Age of the Teacher

The summary of the statistical calculations comparing pupil achievement on the basis of the age of the teacher is shown in Table IX. There is a significant negative relationship ($r = -0.26$). It reaches significance at the .01 level. A check of the data showed no significant departure from linearity except for teachers in the higher age groups. The classes of these teachers had generally high mean achievement but there were so few teachers in these age groups that the scores of their classes made no significant impact on the results as a whole. Generalizations cannot be made on the basis of so few cases.

The indication is that teaching efficiency declines as the teacher grows older. However, this conclusion cannot be justified from the analysis made here.

Time Spent on the Job

The questionnaire, in Item 6, asked the teacher to estimate the number of hours per week that he or she devoted to the teaching job. This information was used to determine whether more time spent led to increased pupil achievement. The results of the calculations are summarized in Table IX. The correlation of -0.03 indicates no significant relationship between the time spent and the achievement of the pupils.

It is possible that teachers who report the most time spent on the job are those teaching in multi-grade classrooms and who spend more time because of the greater number of lesson preparations necessary. This could account for the indication that more time spent does not result in increased effectiveness.

Teacher Attitudes

Some of the factors investigated are all concerned with the feelings of the teachers about certain aspects of teaching. These are dealt with in this section on attitudes. The results of calculations are summarized in Table X.

Teacher preference as to subject area. There is no significant difference in pupil achievement associated with the teacher's preference of subject. The small t-value (0.58) indicates little difference between mean class achievements for teachers who preferred the mathematics-science field and for teacher who preferred to teach in other fields. The mean class achievement for teachers who preferred other fields tended to be higher than the mean achievement for teachers who

TABLE X

RELATIONSHIPS BETWEEN THE CLASS ACHIEVEMENT INDEX AND
TEACHER ATTITUDES

Teacher Attitudes	Variables	Means	Ratio	r _{pbi}	t	Significance <i>t</i> _{.05} = 1.98
Subject preference	Math.-Sc.	50.10	.69	.05	0.58	NS
	Other	51.08	.31			
Feeling of adequate preparation	Math.-Sc.	49.58	.66	.11	1.38	NS
	Other	51.86	.34			
Feeling of permanence in teaching	Yes	49.92	.79	.07	0.93	NS
	No	51.63	.21			

preferred to teach science and/or mathematics.

Feeling of adequate preparation. The teacher may feel more adequately prepared to teach in one subject-field than in another. The teacher's attitude in this regard may have an effect on pupil achievement. Table X contains the summary of the statistical analysis. A point-biserial correlation of +0.11 was found. The corresponding *t* value of 1.38 is not significant. The results for teachers who felt more adequately prepared to teach in the mathematics-science field tended to be lower than the results for teachers who felt less well-prepared in that field.

Feeling of permanence in teaching. Item 50 of the questionnaire asked teachers to indicate whether they felt that they would or would not remain in teaching. Those teachers who checked "Undecided, probably

"will" were grouped with those who answered "Yes." Those who checked "Undecided, probably will not" were grouped with those who answered "No." The results of the statistical analysis are summarized in Table X. No significant relationship between the mean achievement of the pupils and the teacher's feeling of permanence in the profession was found.

None of the three attitudes of teachers studied seemed to have any marked effect on pupil achievement. This would suggest that the concern of teachers about these particular aspects of teaching is not sufficient to affect the quality of the teaching.

Effects of Class Size on Pupil Achievement

During a period of rapid growth in population, a common problem to schools is that of classes becoming too large for the facilities. Knowledge of the effects of the resulting crowding and the resulting decrease in the amount of attention that a teacher can give to individual students is important to school administrators. Administrators should know the size of class which most favors high pupil achievement.

The correlations found between class size and the mean achievement of pupils are shown in Table XI.

The overall correlation of pupil achievement to class size was -0.27. This is significant at the .01 level. It indicates that pupil mean achievement decreased as class size increased. The mean pupil achievement for each size of class is shown in the graph, Figure 3, page 60. Correlations of pupil achievements with class size were worked out between classes of different sizes. A significant relationship

TABLE XI

RELATIONSHIP BETWEEN THE CLASS ACHIEVEMENT INDEX AND CLASS SIZE

Class Size	N	Mean Class Achievement Index	Correlation	Significance
All sizes	156	49.7	-.27	.01
16-20 & 26-30	63	51.2	-.28	.01
16-20 & 31-35	57	49.7	-.44	.01

($r = -0.28$) was found between pupil achievement in classes of from sixteen to twenty pupils and pupil achievement in classes of twenty-six to thirty students. A significant relationship ($r = -0.44$) was also found between the mean achievement in classes of sixteen to twenty pupils and in classes of thirty-one to thirty-five pupils. In both cases, the findings favored the smaller classes. Both relationships reached significance at the .01 level. There were so few classes of thirty-six or more pupils that no attempt was made to work out the correlations for them.

These findings support the common conviction that a teacher is better able to teach effectively in classes of fewer pupils. They also agree with all but one of the studies reviewed. That study by Spitzer found no difference attributable to class size.

Effects of School Organization by Grades

Four types of schools, based on the grades included in the organization, appear in the sample. Type I includes schools with the

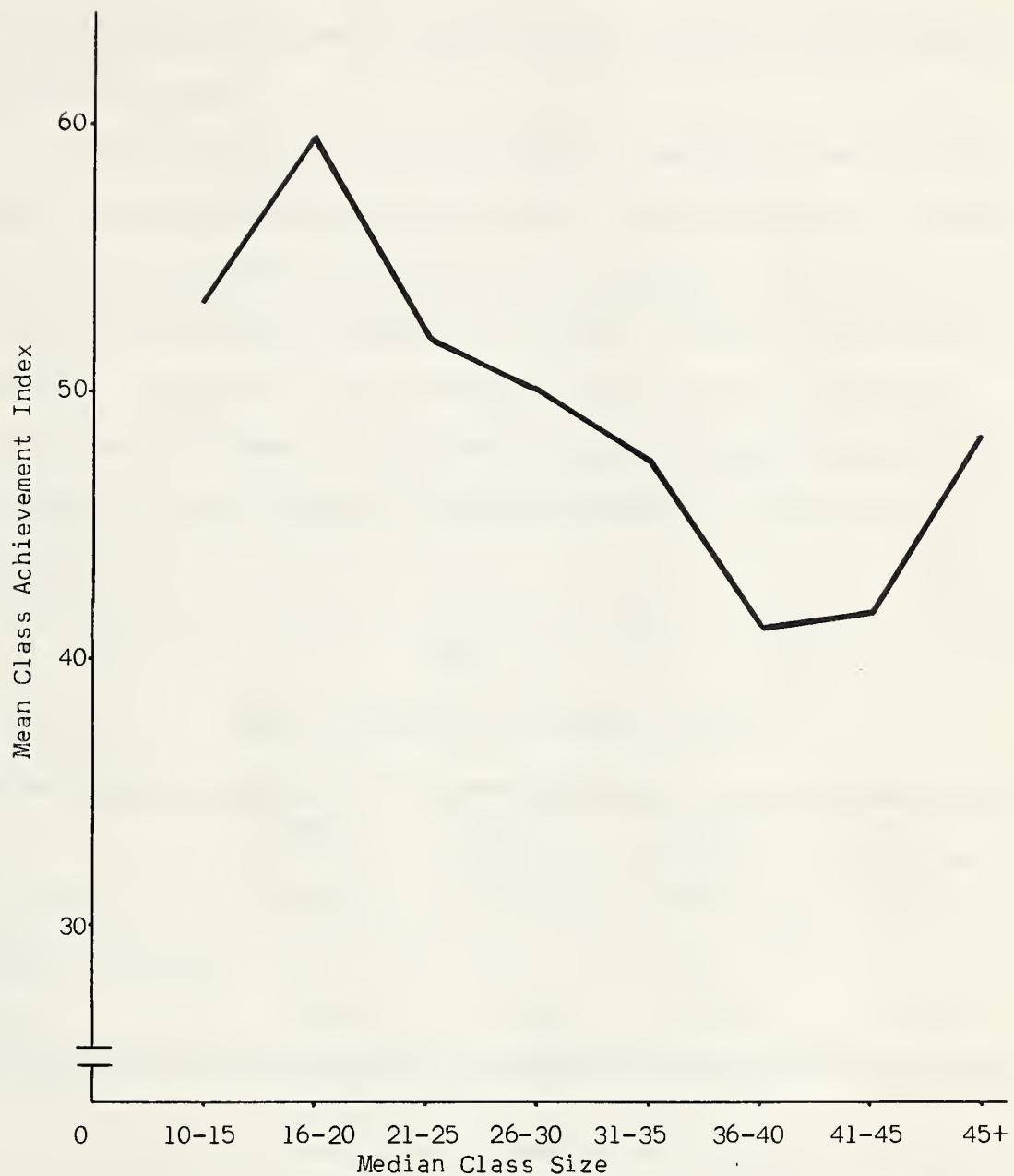


FIGURE 3

THE MEAN CLASS ACHIEVEMENT INDEX BASED ON
MEDIAN CLASS SIZE

junior high grades only; Type II includes schools with junior high and elementary grades; Type III includes those schools with junior high and senior high grades; Type IV includes schools with all grades from one to twelve.

The analysis of variance technique was applied to the data (1: 227). The assumptions and conditions that underly analysis of variance (discussed in Appendix D) are satisfied by the data. The results of calculations are shown in Tables XII and XIII. One-way classification was used. The value $F = 5.33$ indicates that there are significant differences among means. The differences reached significance at the .01 level. It was necessary to determine where the differences occurred.

TABLE XII
MEAN ACHIEVEMENT OF TYPES OF SCHOOLS

	Type I Jr. High	Type II Elem. & Jr. High	Type III Jr. & Sr. High	Type IV All Grades 1-12
Number of Schools	15	54	30	79
Mean	44.97	48.57	47.83	53.24

To compare the means, two at a time, the within-group variance estimate was used. The results of these calculations are summarized in Table XIV. The mean Class Achievement Index for schools containing all grades was higher than for any of the other types of school. The differences between Type IV and the other types were all significant at

TABLE XIII
SUMMARY OF ANALYSIS OF VARIANCE FOR DATA OF TABLE XII

Source Variation	Sum of Squares	df	Mean Square	F
Between	1,453.3	3	484.6	5.33
Within	15,819.8	174	90.9	
				$F_{.01} = 3.91$

TABLE XIV
COMPARISON OF MEANS OF TYPES OF SCHOOLS BY GRADE ORGANIZATION
BY USING WITHIN GROUP VARIANCE ESTIMATE

Types of School Compared	Mean of Class Achievement Index	t	Significance
Type I & Type II	44.97	1.30	NS
Type I & Type III	48.57	0.90	NS
Type I & Type IV	44.97	3.08	.01
Type II & Type III	53.24	0.34	NS
Type II & Type IV	48.57	2.78	.01
Type III & Type IV	47.83	2.65	.01

the .01 level. There were no significant differences in mean class achievement between the other types of schools. Therefore, pupils of schools that contain all the grades had achieved significantly better than the pupils of schools of the other types investigated here.

The findings indicate that the students of schools which include all twelve grades achieved higher mean scores than did the students of schools which contained some of the grades only. There are necessarily many possible factors which have not been taken into account. Schools organized to include all grades are in the smaller centres. It would follow that these schools have smaller enrollments. Thus class size would have to be considered to determine relative effects.

Comparison of City Pupils and Rural Pupils as to Achievement

Comparisons of results achieved by city school pupils and by rural school pupils are summarized in Table XV.

TABLE XV
COMPARISON OF CITY PUPILS AND RURAL PUPILS IN ACHIEVEMENT

Basis of Comparison	City Pupils	Rural Pupils
Mean Raw Score on Ability Test	68.6	.62.9
Mean Stanine Score in Science	4.97	4.94
Expected Stanine Score in Science	5.19	4.71
Mean Class Achievement Index	44.8	52.3
Proportions	.28	.72
Correlation	$r_{pbi} = .34$	$t = 4.76$ $p < .001$

The comparison includes some raw scores to better illustrate the results of removing the effects of differences in intelligence. The calculations reveal that the scores of the city students in the Grade 9 Science Examination were better than the scores of rural students. City students also scored considerably higher on the Ability Test. In view of the high positive correlation of the Ability Test scores with the Science 9 scores (0.73), city students should have done better than they did on the Science Examination. By the same token, an examination of results by rural students shows they did better than might have been expected. Thus, the Class Achievement Index scores are lower for city pupils than for rural pupils. The point-biserial correlation reveals an r_{pbi} value of 0.34 and a t value of 4.76 in favor of rural pupils. This difference is significant at the .001 level. The results of rural pupils are higher than those of city pupils when the intelligence factor is removed.

Comparison of City Teachers with Rural Teachers on the Basis of Some Teacher Characteristics

The results of calculations by which city teachers and rural teachers are compared with regard to a number of teacher characteristics are given in Table XVI.

Professional training. With regard to professional training, city teachers had significantly more than their rural counterparts. The difference in amount of training reached significance at the .001 level. Although there were relatively few teachers who reported that

they had taken science courses at university, and thus there is more likelihood of a biased sample, the calculations show that city teachers took more courses. Of the city teachers, 45 out of 50 had taken such courses. Of the rural teachers, only 35 out of 130 had done so.

TABLE XVI

COMPARISON OF RURAL AND CITY TEACHERS ON SOME TEACHER CHARACTERISTICS

Teacher Characteristics		N	Mean	Ratio	Pooled SD	r_{pb1}	t	Significance
Professional training	R	130	2.3	.72	1.81	.38	5.1	.001
	C	50	3.8	.28				
Extra Science courses	R	45	2.4	.56	2.22	.27	2.5	.02
	C	35	3.6	.44				
Teaching experience	R	129	11.1	.72	8.98	.50	7.7	.001
	C	50	16.6	.28				
Time spent in system	R	126	5.0	.72	5.69	.20	2.7	.01
	C	50	7.3	.28				
Age	R	129	36.4	.72	10.96	.15	2.0	.05
	C	50	40.1	.28				
Time spent on job	R	129	47.0	.72	7.45	.18	2.4	.02
	C	49	44.0	.28				

The evidence of the statistics in this study indicate that the city teachers are much better prepared in terms of professional education.

Teaching experience. The average rural teacher has had 11.1 years of teaching experience while the average city teacher has had 16.6 years. The statistical difference is significant at the .001 level.

This indicates that the city teachers who are teaching Grade 9 Science have had considerably more experience than the rural teachers have had. The negative correlation of experience to pupil achievement and the finding that rural pupils achieve better than city pupils are both reflected in this finding.

Time spent in the school system. The average rural teacher in the sample had spent 5.0 years in the school system in which he or she was then teaching. The average for the city teachers was 7.3 years. Tests show that this difference is significant at the .01 level. Teacher retention in the cities would not appear to be the problem that it is in rural school systems.

Age of the teacher. The average age of the rural teachers was 34.6 years while the average age of the city teachers was 40.1 years. The difference in age was significant at the .05 level. A conclusion that might be reached is that the average city science teacher in Grade 9 was older than the average rural teacher who taught Grade 9 Science.

Time spent on the job. For rural teachers, the average estimate of the time spent at teaching and related work was 47.0 hours. The average of the estimates of city teachers was 44.0 hours. The difference in these estimates is significant at the .02 level. The indication is that rural teachers work longer hours than city teachers do. Earlier analysis indicated that the extra time spent did not significantly affect pupil achievement. The reason could be that the rural teacher is engaged to teach more subjects and thus has more lesson preparations

to make. Thus the extra hours spent on teaching duties did not result in better teaching in Science.

Subject-field teaching preference. Table XVII shows the results of calculations to determine whether city teachers or rural teachers were more often working in the area of their subject-preference.

TABLE XVII
CITY TEACHERS COMPARED WITH RURAL TEACHERS RELATIVE TO
SUBJECT-FIELD TEACHING PREFERENCE

	Teaching Preference Mathematics- Science	Other	Totals
City teachers	41	7	48
Rural teachers	78	49	127
Totals	119	56	175
Chi-square = 9.42		df = 1	p < .01

The method of chi-square (1:157) was used to test the significance of the difference between proportions. The finding was that city teachers were much more often teaching subjects that they preferred to teach. The value of chi-square indicates the difference in proportions is significant at the .01 level. In view of the greater departmentalization and subject exchange by teachers in city schools, this finding is to be expected. It is not known, however, to what extent city teachers are able to teach just in the subject-field of their preference even though there is this departmentalization.

III. TESTS OF HYPOTHESES

In this chapter of the study, statistical analysis and interpretation of the results have been presented. The findings as they apply to the hypotheses are summarized here.

1. No significant relationship was found between the mean class achievement, as measured by the Class Achievement Index, and the amount of professional training of the teacher. The correlation coefficient was negative and approached a significant level.

2. The achievement of pupils in Grade 9 Science was not significantly affected by the number of physical science courses included in the teacher's university program.

3. There was a negative correlation between the amount of teaching experience and the Class Achievement Index. The relationship reached significance at the .01 level.

4. There was a significant positive relationship between the time that a teacher had spent in the school system and the Class Achievement Index. The correlation was significant at the .01 level.

5. There was no significant relationship between the sex of the teacher and teaching efficiency as measured by the Class Achievement Index.

6. There was a significant negative relationship between the age of the teacher and the Class Achievement Index. The relationship was significant at the .01 level.

7. There was no significant relationship between the number of hours per week that the teacher spent on the job and the mean achievement

of the class.

8. There was no significant relationship between the Class Achievement Index and such attitudes of the teacher as subject-field preference, feeling of adequate preparation in the subject-field, or a feeling of permanence in the teaching profession.

9. The results obtained by rural pupils were significantly better than those obtained by city pupils as measured by the Class Achievement Index. The Class Achievement Index was designed to remove the effects of intelligence differences. The value of t indicated significance at the .001 level.

10. There was a significant relationship between pupil achievement and class size. The r value of -0.27 is significant at the .01 level. Pupil achievement means decreased as class size increased. Achievement for classes of sixteen to twenty pupils tended to be better than achievement for either larger or smaller classes. The achievement of the classes containing sixteen to twenty pupils was significantly higher than the achievement of classes of twenty-six to thirty students and of classes of thirty-one to thirty-five pupils.

11. Pupils of schools that contained all twelve grades achieved higher scores than pupils of any other type of school. The difference in mean scores was significant at the .01 level in all cases. The mean achievements of pupils in other types of schools did not differ significantly.

12. There was no significant relationship between the Class Achievement Index and the type of degree held by the teacher. There

was no relationship between pupil achievement for teachers with one degree and for teachers with two degrees.

13. The achievement of pupils of undergraduate teachers was significantly higher than the achievement of the pupils of graduate teachers. The relationship reached significance at the .01 level.

14. There were significant differences between city teachers and non-city teachers. City science teachers had more professional training; they had taken more physical science courses at university; they had had more teaching experience; the average age of the city teachers was greater.

15. City teachers had spent more time in the school system. Rural teachers estimated that they spent more time on the job. More city teachers were teaching in their subject-preference field.

IV. SUMMARY

The Statistical Methods Used

This chapter has dealt with the statistical treatment of the data and the results of the statistical tests. Pearson product-moment correlations were used to determine relationships between variables of the interval or ratio types. Point-biserial correlations were used when one variable was dichotomous. The appropriate t-values were found to determine whether there were significant relationships. Chi-square was used to determine differences between proportions. Analysis of variance was used to compare mean achievement scores of different types of schools.

Class Achievement Index

A regression equation was developed and used to predict science scores from the Ability Test scores. A class index was computed which was the difference between the actual mean science score for the class of pupils and the science score predicted for that class. These index scores were converted to T-scores. The T-score for a class was termed its Class Achievement Index. The purpose of this procedure was to remove the effects of variations in pupil intelligence.

Statistical Analyses

Some of the relationships that were found are shown in Table XVIII. Other relationships did not fit readily into a table.

The feelings of the teachers about the adequacy of their own preparation and their permanence in the profession bore no relationship to pupil achievement. Undergraduate teachers seemed more effective than graduate teachers in teaching Grade 9 Science. Pupil achievement was higher in schools that contained all twelve grades than in schools containing fewer grades.

It was found that rural pupils achieved significantly higher scores than city pupils.

No significance could be attached to whether the teacher had a degree in education or in some other faculty. Teachers with one degree were as effective as teachers with two degrees.

TABLE XVIII

CORRELATIONS FOUND IN THE STATISTICAL ANALYSES

Teacher Characteristics	Class Achievement Index		Between City and Rural Teachers Relationship in favor of		Significance
	Relationship	Significance			
Professional education	none		city		.001
University courses	none		city		.02
Teaching experience	negative	.01	city		.001
Time spent in school system	positive	.01	city		.01
Sex	none		--		
Age	negative	.01	city		.05
Time spent on the job	none		rural		.02
Teaching of preferred subject	none		city		.01

REFERENCES FOR CHAPTER IV

- (1) George A. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Book Company, Inc., 1959).
- (2) Helen M. Walker and Joseph Lev, Statistical Inference (New York: Henry Holt and Company, 1955).

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

I. SUMMARY OF FINDINGS

This study was undertaken to determine the relationship between teacher effectiveness as measured by the Class Achievement Index and certain objectively measurable characteristics of the teacher or of the school. The Class Achievement Index was devised as a measure of pupil achievement in science with effects of intelligence differences removed.

The study also made comparisons, on the basis of six of the same measurable characteristics, between city teachers and rural teachers.

A search of the literature available on research done in this field has indicated that there is a lack of general agreement on the significance of the effect of most of the factors investigated. The studies reviewed were primarily concerned with measuring teacher effectiveness, with pupil growth or achievement as the criterion. The various studies attempted to measure pupil achievement in quite different ways. Some used an intelligence control and some did not.

For the correlations between class achievement and the teacher variables that are continuous, and also for the continuous variables pertaining to the school, the Pearson's product-moment procedure was used. Throughout the study, for comparisons in which one set of variables was dichotomous, point-biserial correlations were calculated and the corresponding values of t used to determine significance of the

relationships. For tests of normality of distributions and for testing the significance of a difference between proportions, chi-square tests were used. The technique of analysis of variance was used on one problem.

The following were the findings:

1. Three of the Alberta studies and a number of the other studies reviewed found that the amount of professional education of the teacher had a significant positive correlation with pupil achievement. This study found that the relationship between mean class achievement and the amount of professional education of the teacher did not reach the level of significance.

2. This study revealed no significant relationship between pupil achievement and the number of university courses in the physical sciences that the teacher had taken. Seven of the studies were Alberta studies. Three studies found negative correlations. One other study found no significant relationship.

3. Class achievement decreased with an increase in the amount of teaching experience. However, a definite positive relationship was found between class achievement and the length of the teacher's service in the school system. A graph of the data for teaching experience was used to detect gross errors in calculations and to discover any marked departures from linear relationships. There was an indication that ten to fourteen years was more effective than more or less experience. The studies reviewed which found that teaching experience had a significant effect reported that experience up to ten or twelve years had a

significant effect on pupil results.

4. This study found no significant relationship between the sex of the teacher and mean class achievement. All but one of the studies reviewed reported no significant relationship.

5. No reason was found to disagree with the rather common finding that pupil achievement and teacher age are negatively correlated.

6. The achievement of pupils of teachers who spent more hours per week at duties related to teaching was not significantly better than the achievement of pupils of teachers who spent less time. The study did not determine how the teachers spent this time. It cannot be assumed that extra hours spent mean that extra time was spent on the teaching of science.

7. Preference for teaching in the mathematics-science field or a feeling of adequacy in this field did not have any significant effect on the class achievement. However, those Alberta studies reviewed which investigated subject-preference of the teacher found a significant positive effect on pupil achievement when the teacher was teaching the subject preferred.

8. Evidence indicated that, with intelligence being equal, rural classes achieved better than city classes in Grade 9 Science.

9. It was found that pupil achievement varied inversely with class size. This finding is in agreement with other studies that found a relationship.

10. Various grade combinations are used to make up an administrative unit. Schools were classified by the grade combinations that they

included. This study found that schools with all twelve grades had better mean class achievement than schools with other grade combinations.

11. There was no significant relationship between mean pupil achievement and the faculty in which the teacher held his degree. Whether the teacher had one or two degrees did not appear to have a significant effect on pupil achievement.

12. The pupil achievement in the classes of undergraduate teachers was higher than pupil achievement in the classes of graduate teachers.

13. City teachers exceeded rural teachers in: (a) amount of professional training; (b) the number of extra physical science courses taken at university; (c) length of teaching experience; (d) length of time spent in the school system; and (e) average age.

14. More city teachers were working in their subject-preference field.

15. Rural teachers' estimates of the time spent per week at teaching and related duties exceeded city teachers' estimates of the time devoted to teaching. The questionnaire did not provide information as to estimates of the amount of this time spent in teaching of science.

II. CONCLUSIONS

The results lead to the conclusion that in certain areas of teaching the professional training of the teacher is a matter of great importance. This is no doubt particularly true of instruction in highly technical fields. The amount of professional training does not, however, seem to be so important for teaching Grade 9 Science. It may be that the teacher who does not have the specialized training is learning along with the pupils and can appreciate difficulties in the assimilation of the concepts. The teacher who has specialized may set his goals too high and thus even hinder the progress of the pupils.

The teacher with more specialized training may use a broader approach to the curriculum. It is probable that a teacher who makes intensive use of a number of the past examinations may prepare the class to write the type of examination with which this study is concerned. The teacher would not necessarily have to have a broad science background to be able to do this. If this is so, it becomes a question of what the goals of the science course should be and what was measured by the science examinations.

It must be noted that the item from the questionnaire which was used to determine the number of university courses that the teacher had taken in the science field asked for the number of courses taken in the physical sciences. The subsequent question asked for the number of courses taken in the biological sciences. The responses to this question were not considered in the study. There was a

considerable amount of biological material in the science course. Had these courses been included, findings may have differed.

Since the approach of this study was cross-sectional rather than longitudinal, there are questions about the effects of teaching experience and of age of the teacher that cannot be answered. One question is whether the apparent decrease in efficiency with increased experience and age is a reflection of cultural influences, particularly those impressed on teachers at the time of their teacher training. These influences may differ a great deal for the older teacher groups and for the younger teacher groups. The philosophy of teacher training, of teaching, and of education in general has changed considerably over the forty-year interval during which the teachers involved in this study were trained. Again, the examinations may be unduly favorable to the cultural influences and the philosophies that have had a greater effect on the younger teachers.

Another question to which an answer cannot be found in the results of this study is that of the effect of selection from the teaching ranks of personnel for administrative and supervisory positions on the quality of the higher age teaching group. Many of the most capable people have been selected for promotion.

Much of the reason for negative correlations of pupil achievement with professional training, teaching experience, and a finding such as better results obtained by undergraduate teachers may be reflections on the effects of class size. One finding of this study was that class achievement of larger classes was lower than that of

smaller classes. Classes of from sixteen to twenty pupils had higher mean achievement scores than classes that were from five to fifteen pupils larger.

The finding that achievement of rural pupils was higher than the achievement of city pupils might also be due partly to relative class size. The rural classes were, without doubt, smaller than city classes. The schools that contained all twelve grades were almost without exception in the group classified as non-city. These schools were organized in this way because lower enrollments made it feasible to administer all grades in one school. Thus class size may be an important factor.

There was a substantial rural orientation in the science curriculum. The sections on soils and soil conservation, on selective breeding, and on various breeds of farm animals were doubtless more meaningful to rural students. The fact that these parts of the course are more closely related to practical experience of rural students is probably part of the reason that they achieved higher scores in the science examination than the city students did.

The finding that undergraduate teacher obtained higher pupil achievement is possibly related to these same factors. The undergraduate teachers who are teaching Grade 9 Science may be predominantly in the non-city schools and thus also handling smaller classes. More of the undergraduate teachers were in rural schools.

The positive correlation between pupil achievement and longer service by the teacher in the school system brings attention to ways

of improving the retention of teachers. It may be found that the efficient teacher tends to stay longer in the school system.

III. IMPLICATIONS

The results of this research have some implications for further research and for improvements in educational practice.

Further Research

1. Further research should attempt to determine the reasons why more professional education does not lead to greater teacher effectiveness in the teaching of Grade 9 Science. Study should be made of the effect on teaching efficiency of various university courses and degree programs.

2. The reasons should be sought for the rather common finding that teaching efficiency decreases with experience beyond ten or fifteen years. The reasons why teaching effectiveness decreases with increased age may be closely related. Research might look into the attitudes toward the job of teachers who have not received promotions. It may be that their teaching lacks inspiration and variety.

3. Present examination practices in Grade 9 in Alberta should be subjected to close scrutiny. Research should try to determine whether the present practices actually measure the results of successful teaching. A valid measure and definition of good teaching is still one of the most important problems to solve.

4. Longitudinal studies on class size are becoming increasingly important. Various economic and personnel problems continue to

dictate, at least partially, the policies of school administrations with regard to class size.

Teacher Training

1. Research should determine the value of a well-defined and well-organized program of in-service training and refresher courses for all teachers. Would such programs inject more vitality into teaching?
2. The finding that increased professional training does not lead to increased efficiency may be a reflection on present programs for educating teachers. Research should determine how well courses offered prepare teachers to teach certain subjects, science for instance.

School Administration

1. The positive relationship between class achievement and longer service by the teacher in the school system indicates that teacher retention should be improved. School authorities should determine what research has to say and then try to improve retention techniques.

2. There are physical factors such as grade organization and class size that can be controlled and might be factors in securing better education. School administrators should pay close attention to innovations in school design and organization. Increased expenditures and careful planning are needed to provide facilities and staff sufficient to enable necessary control of class size.

In considering the results of the research conducted, it is

necessary to keep in mind that all conclusions are necessarily probability estimates. Relationships, differences, and predictions are based on information about groups of teachers and groups of students. Thus the conclusions should apply to groups in the same, or similar conditions.

As with most research projects, this study has resulted in more questions than answers. It has brought to the researcher an increased respect for the complexity of the teaching function. The need is seen for attempts to provide more precisely-defined criteria and to improve the quality and range of evaluative instruments. It is hoped that this study will help in some way to that end.

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APPENDICES

APPENDIX A

EXCERPTS FROM THE PROVINCE OF ALBERTA ROYAL COMMISSION ON EDUCATION SURVEY OF ALBERTA TEACHER FORCE INDIVIDUAL TEACHER'S REPORT

The following items from the questionnaire were used to obtain the teacher data used in this study.

4. If you teach more than one class, what is the ENROLMENT of the median-sized (middle-sized) CLASS which you teach? Consider a class to be defined as in Question 3. Check ONE.

1. . . . Under 10 pupils	6. . . . 31 to 35 pupils
2. . . . 11 to 15 pupils	7. . . . 36 to 40 pupils
3. . . . 16 to 20 pupils	8. . . . 41 to 45 pupils
4. . . . 21 to 25 pupils	9. . . . Over 45 pupils
5. . . . 26 to 30 pupils	
3. Definition of class: If you supervise some pupils while teaching others, consider a class to be the total number of pupils for whom you have sole charge in your room at any one time.
6. What is the average NUMBER OF CLOCK HOURS per week that you devote to your teaching job? Include all time spent in activities which are required or definitely expected of you, whether you do your work at home, at school or elsewhere. Check ONE.

1. . . Under 30 hours	6. . . 50 to 54 hours
2. . . 30 to 34 hours	7. . . 55 to 59 hours
3. . . 35 to 39 hours	8. . . 60 to 64 hours
4. . . 40 to 44 hours	9. . . 65 or more hours
5. . . 45 to 49 hours	
7. In what TYPE OF SCHOOL DO YOU TEACH? For this question and the next three questions, consider your school to be the organization under the direct control of your principal. Check ONE.
 1. . . Elementary (School has some of Grades I to VI, but no Grade above VI)
 2. . . Junior High School (School has some of Grades VII to IX, but no grades below VII or above IX)
 3. . . Senior High School has some of Grades X to XII, but no grades below X)
 4. . . Elementary and Junior High
 5. . . Junior High and Senior High
 6. . . Elementary, Junior and Senior.

11. In what TYPE OF ADMINISTRATIVE UNIT is your school? If it is in a School Division or County, Check under A. If it is in an Independent (Non-Divisional) District, check ONE under B.

A. . . In a School Division or County.

B. . . In an Independent (Non-Divisional) District.

 1. . . A City District (not R.C. Separate)
 2. . . A Town District (not R.C. Separate)
 3. . . A Village District (not R.C. Separate)
 4. . . A Consolidated District (not R.C. Separate)
 5. . . A Rural School District (not R.C. Separate)
 6. . . A City District (R.C. Separate)
 7. . . A Town District (R.C. Separate)
 8. . . A Village or Rural District (R.C. Separate)
 9. . . Other (Please write in).

15. WHAT IS THE EXTENT of your TOTAL ACADEMIC AND PROFESSIONAL PREPARATION BEYOND HIGH SCHOOL? Check ONE.

 1. . . Less than a standard 1-year program (7 months) in a Normal school, Teachers' College, or University
 2. . . A standard 1-year program (7 months or more) in a Normal school, Teachers' College, or University
 3. . . 2 complete years but less than 3 in a University and/or Teachers' College
 4. . . 3 complete years but less than 4 in a University and/or Teachers' College
 5. . . 4 complete years but less than 5 in a University and/or Teachers' College
 6. . . 5 complete years but less than 6 in a University and/or Teachers' College
 7. . . 6 or more complete years in a University and/or Teachers' College

18. What is the HIGHEST UNIVERSITY DEGREE you hold? Check ONE.

 1. . . No degree
 2. . . B.A.
 3. . . B.Sc.
 4. . . B.Ed.
 5. . . Two or more Bachelor degrees
 6. . . M.A.
 7. . . M.Sc.
 8. . . M.Ed.
 9. . . Other (Please write in).

42. Counting the present year, what is the number of years of full-time teaching experience you have had IN THE SCHOOL SYSTEM where you are now teaching? Check ONE.

- | | |
|----------------------|----------------------|
| 1. . .1 year | 6. . .15 to 19 years |
| 2. . .2 years | 7. . .20 to 24 years |
| 3. . .3 to 4 years | 8. . .25 to 34 years |
| 4. . .5 to 9 years | 9. . .Over 34 years |
| 5. . .10 to 14 years | |

50. Do you plan to CONTINUE teaching until retirement? Check ONE.

1. . .Yes.
2. . .Undecided, probably will.
3. . .Undecided, probably will not.
4. . .No

51. Please indicate your SEX. Check ONE.

1. . .Male. 2. . .Female

53. What is your AGE (Nearest Birthday)? Check ONE.

- | | |
|----------------------|----------------------|
| 1. . .Under 21 years | 6. . .41 to 45 years |
| 2. . .21 to 25 years | 7. . .46 to 55 years |
| 3. . .26 to 30 years | 8. . .56 to 65 years |
| 4. . .31 to 35 years | 9. . .66 or over. |
| 5. . .36 to 40 years | |

APPENDIX B

LETTER TO PRINCIPALS

This letter was sent to the principals of those schools in which more than one teacher was teaching Grade 9 Science. It was accompanied by a list of student names obtained from Department of Education files. The names of teachers were also supplied to aid in identification.

Provost, Alberta,
October 10, 1961.

Dear

Could I bother you for some information about your Grade 9 class of the year 1957-1958? I am working on the M.Ed. degree in Educational Administration at the University of Alberta. I have chosen as my thesis topic "The Relation of Pupil Achievement in Science to Teacher Characteristics and Certain Environmental Conditions."

Enclosed is a list of the names of the students of your school who wrote the Departmental Examinations in June, 1958. Since your Form A card showed more than one teacher for Grade 9 Science, my problem is the identification of each student with his science teacher. Would you consult your records and indicate beside each student name the teacher that taught the student in science? The list of the Grade 9 Science teachers as I have them is attached to the student list. If it is impossible to make complete identification, I would appreciate the information to the extent that you can give it. A stamped self-addressed envelope is enclosed.

The reason that I am asking for information as old as this is that part of my data, teacher characteristics, is being obtained from the data collected for "The Alberta Teacher Force of 1957-1958," which was done by Dr. R. S. MacArthur and Mr. S. A. Lindstedt for the Cameron Commission on Education.

Thank you very much for your trouble and your cooperation.

Yours truly,

APPENDIX C

TABLE XIX

BIVARIATE FREQUENCY DISTRIBUTION OF STUDENT RESULTS ON THE GRADE IX SCIENCE
AND MENTAL ABILITY EXAMINATIONS ($r = .73$)

		Raw Scores on Mental Ability Examination (X)										
		16-25	26-35	36-45	46-55	56-65	66-75	76-85	86-95	96-105	106-115	Totals
Stanine Scores on Science Examination (Y)	9			2	9	46	108	111	8	284		
	8			4	16	59	146	196	84	5	510	
	7			1	13	62	197	283	203	3	826	
	6	1	2	13	100	207	319	309	156	30	1137	
	5	2	8	53	186	321	348	207	53	5	1183	
	4	1	21	129	318	341	217	98	20	1	1146	
	3	5	46	207	291	251	125	26	5	2	958	
	2	4	61	138	155	94	26	4			482	
	1	9	64	92	56	20	3	1			245	
Totals		22	202	633	1123	1314	1303	1120	741	297	16	6771

APPENDIX D

ASSUMPTIONS UNDERLYING THE ANALYSIS OF VARIANCE

The following assumptions are made in the mathematical development of the analysis of variance:

1. The distributions of the variables in the populations from which the samples are drawn are normal.
2. The variances in the populations from which the samples are drawn are equal. This is known as homogeneity of variance.
3. The effects of various factors on the total variation are additive (1:239).

Lindquist (2:86) says:

Unless the departure from normality is so extreme that it can be easily detected by mere inspection of the data, the departure from normality will probably have no appreciable effect on the validity of the F-test, and the probabilities read from the F-table can be used as close approximations to the true probabilities.

A maximum F-ratio test as described by Walker and Lev was used. According to this test, the value of F is calculated by taking the ratio of the largest sub-group variance to the smallest sub-group variance. If this ratio is sufficiently great to yield a significant value for F, it cannot be assumed that the sub-groups are internally homogeneous (3: 191). To explore this possibility, a maximum F-test of homogeneity was carried out for each of the measures; in this case, the types of schools. The variances of the groups were quite homogeneous in all cases.

Additivity of effects has been assumed.

One advantage of the analysis of variance is that reasonable departures from the assumptions of normality and homogeneity may occur

without seriously affecting the validity of the inferences drawn from the data (1:240).

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